Department of Pesticide Regulation

Paul E. Helliker
Director

Gray Davis
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Winston H. Hickox
Secretary, California Environmental Protection Agency

May 21, 2001

TO: Interested Parties

SUBJECT: METHYL BROMIDE SUBCHRONIC EXPOSURE--ANALYSIS OF DATA AND RISK MANAGEMENT OPTIONS

In 2000, the Department of Pesticide Regulation (DPR) requested that the Air Resources Board (ARB) conduct ambient air monitoring for fumigants, including methyl bromide, to determine long- and short-term risks. Monitoring data for methyl bromide indicated that short-term levels were acceptable. However, data also indicated that ambient concentrations in some locations exceeded some health-based reference concentrations. Upon receiving this data last winter, DPR immediately developed a work plan to analyze the data, evaluate factors that affect air concentrations, and to evaluate various risk management options. DPR targeted completion of the work plan to coincide with the earliest peak use season, which typically begins in July.

DPR staff completed major portions of their analysis of the data and identified major factors that could be considered for risk management. We would like to keep you aware of the information we are developing on this issue and various options we expect to consider. We also welcome comments and thoughts on other perspectives on the data interpretation and possible risk management options. As you will find in the attached documents, DPR staff have compiled all available pesticide use information from the monitoring locations. However, we know that that information may not be complete. As we continue evaluating this analysis over the next few weeks, we will continue to refine our information.

DPR is currently completing its evaluation of the impacts that implementation of the January 2001, field fumigation regulations and the continued phaseout of methyl bromide will have on ambient air concentrations. DPR expects to announce any proposed changes to methyl bromide regulations by June 18, 2001, in order to have them pertain to the 2001 use season. Obviously this leaves little time for you and our staff work on this issue. Therefore, we would appreciate your thoughts on this issue by June 8, 2001.

Please provide any written comments on the attached materials to Mr. Ronald J. Oshima, DPR's Assistant Director for Scientific Affairs. You may send them to him at the address on this letterhead, or e-mail him at <roshima@cdpr.ca.gov>.

Sincerely,

Paul Helliker

Paul E. Helliker
Director
(916) 445-4000

Attachment

cc: Ronald J. Oshima (w/Attachment)

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Methyl Bromide Subchronic Exposure: Analysis of Data and Risk Management Options

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Background

The Department of Pesticide Regulation (DPR) has broad authority over the registration, sale, and use of pesticides in California to protect health and the environment. This authority is derived from a number of laws that cover all aspects of pesticide use in all media–air, ground and surface water, food, and in occupational and home-and-garden settings. DPR evaluates pesticides before they can be sold to ensure they meet California's high environmental and health standards, and monitors their use after sale to ensure they are being used safely.

DPR has conducted methyl bromide monitoring periodically for a number of years, under its general authority and mandate to continuously evaluate the use of registered pesticides and more specifically, as part of the State's Toxic Air Contaminant (TAC) Program. Under the TAC program, DPR requests that State Air Resources Board to conduct monitoring of ambient air for specific pesticides in seasons and areas of historically high use.

Methyl bromide was identified as a toxic air contaminant in 1996. Farmers use methyl bromide to treat soil before planting vegetable, fruit and nut crops, and flower and forest nurseries. Depending on the crop, field applications may occur annually, or once every several years. Methyl bromide is injected into the soil with specialized application equipment that lays tarpaulins over the ground to minimize off-gassing for several days. After harvest, methyl bromide fumigation protects crops from pest damage during storage and transportation. The fumigant is also used for termite eradication in homes and other structures, and to control insects in mills, ships, railroad cars and other transportation vehicles.

Because of changing use patterns and other factors, DPR requested that ARB conduct additional monitoring in 2000 for methyl bromide and other fumigants. This monitoring was part of an ongoing effort to evaluate seasonal exposures to methyl bromide and determine if current restrictions provide adequate safety for people in areas where fumigations occur to multiple fields. The monitoring was conducted before new regulatory restrictions on methyl bromide went into effect in January 2001. These restrictions, specifically designed to address short-term, acute exposures, include larger buffer zones that increase with the size of field being treated. (A "buffer zone" is the area that surrounds a pesticide application block; within this area, activities are restricted to protect human health and safety.) These restrictions are expected to alter use patterns; monitoring to be done during the 2001 use season will help determine how new use

patterns will effect ambient air levels.

The purpose of this analysis is to describe the relationship of the monitoring results to health-based standards, factors contributing to the air concentrations and possible risk management options available to manage exposures.

2000 Monitoring Study

Monitoring was conducted within the areas and periods of historically high use. Within each area of high use, ARB selected monitoring stations based on several criteria, including unrestricted air flow around the samplers, proximity to agricultural fields and people, availability of electrical power, accessibility, and security. Schools often meet this selection criteria, and they comprised seven of the 12 sites.

In Kern County, where methyl bromide is primarily used on land to be planted with carrots or flower crops, ARB monitored six locations from July 19 to September 1, 2000 (Figure 1). At each Kern County location, one-day samples were collected four days per week for seven weeks. ARB also monitored six locations in Monterey and Santa Cruz counties, from September 11 to November 3, 2000 (Figure 2). In these counties, methyl bromide is primarily used to prepare land for strawberry plantings. At each location in the Monterey-Santa Cruz area, one-day samples were collected four days per week for eight weeks. At both locations, Silcosteel® canisters were used and additional samples were collected for quality control. The ARB reports (ARB, 2000; ARB, 2001) give complete descriptions of the monitoring.

All but one of the 320 samples contained a detectable and quantifiable amount of methyl bromide (detection limit 0.002 parts per billion [ppb], quantitation limit 0.01 ppb). The highest one-day concentration detected was 30.8 ppb. The highest one-week average concentration was 15.5 ppb. The highest concentration averaged over the entire study period (7 or 8 weeks) was 7.7 ppb. The quality control data indicates that ARB's methodology recovers approximately 100 percent, so no recovery adjustments have been made to the data. The results are summarized in Table 1, and the complete results are given in Appendix A.

Evaluation of Health Risks

To evaluate the risks, DPR compares the methyl bromide detected in the air with health-based reference concentrations. The reference concentrations are methyl bromide concentrations that did not cause any toxic effects in experimental animals (DPR, 1999). For a one-day exposure, the health-based reference concentration DPR seeks to achieve is 210 ppb averaged over 24 hours. For a one-week average exposure, the health-based reference concentration is 70 ppb for children and 120 ppb for adults, again averaged over the entire exposure window of one week.

The risk assessment also identified a health-based reference concentration 54 ppb over two to five weeks of exposure. For an eight-week exposure average, the reference concentration is 1 ppb for children and 2 ppb for adults. These reference concentrations, in addition to being based on absence of toxic effects, also have a built-up 100-fold safety margin to ensure public health protection. Air levels exceeding the reference concentrations, depending on the extent, would not necessarily pose an immediate health risk but may require mitigation to reduce the exposure.

Additional Risk Analysis

The results from the 2000 monitoring study showed that air concentrations for all one-day and one-week periods were below the reference concentrations. In addition, no five-week exposure values approached 54 ppb. However, air concentrations over the seven- to eight-week periods were above the reference concentration for this duration (Table 1). For the location with the highest concentration, the eight-week exposure was almost eight times the target level of 1 ppb. A complete description of the health appraisal is given in Appendix B.

Analysis of ARB Monitoring Data and Pesticide Use Data

Ambient air concentrations from multiple fumigations are affected by proximity to the fumigations, the number of fumigations, and the period over which they occur. To determine the effect of proximity, pesticide use report data was evaluated, comparing methyl bromide applications reported for the July through November 2000 monitoring period with the monitoring data. Historical use patterns accurately predicted current use, and monitoring was conducted near most of the sections with the highest reported use (Figures 1 and 2). To determine if methyl bromide air concentrations correlated with pesticide use patterns, the amount of methyl bromide reported used was aggregated in various combinations of time and distance from the monitoring sites. Methyl bromide use was compiled for various-sized blocks from one to seven miles around each monitoring site, that is, in areas three-by-three miles square, five-by-five miles, seven-by-seven miles, nine-by-nine miles, 11-by-11 miles, and 13-by-13 miles. For each of these seven different-sized blocks, reported methyl bromide use was compiled for three intervals: one, four, and eight weeks (Table 2). The amount of methyl bromide used in each of these area blocks around fumigations was compared to measured air concentrations (Figures 3 and 4). A three-mile distance from the fumigation (a block totaling seven-by-seven square miles) for eight weeks was most closely correlated to air concentrations (Table 3).

Because data collected was limited to a few data points, the assumption was made that ambient air concentrations were wholly dependent on amount of methyl bromide used in the area and distance from the fumigation. (There was insufficient data to take geographic or seasonal factors into account. In addition, in coastal areas, there are background levels of naturally occurring methyl bromide emitted by the ocean; however, studies have demonstrated these levels to be in

the low parts per trillion, a hundred times lower than concentrations monitored following methyl bromide fumigations.) To achieve the 1 ppb target reference concentration, and using this methodology of estimating ambient air levels, methyl bromide use should not exceed 120 pounds per section per week, or approximately 18,000 pounds per township per month (Table 4). (A *section* is a land unit of 640 acres [one square mile] equal to 1/36 of a *township*, which in turn is a square parcel of land, six miles on each side.)

This methodology can be used to calculate a limit on the amount of methyl bromide that can be used so as not to exceed other target concentrations. This analysis also indicates that fumigations three to four miles away have minimal effect on air concentrations measured at the monitoring sites, assuming a 1 ppb target concentration. A complete description of this analysis is given in Appendix C.

There are several caveats to this analysis. First, this analysis only includes pesticide use data from field fumigations. Pesticide use data for structural, commodity, and other types of methyl bromide fumigations is not amenable to this type of analysis because it does not include information on specific location or date, and is incomplete for 2000. Second, this analysis assumes that all pesticide use data for field fumigations is complete and accurate. Missing or incorrect data could significantly alter the calculations. Missing data would cause an underestimation of the amount of methyl bromide that correlates with a specific air concentration. In other words, the 1 ppb reference concentration would equate to more than 18,000 pounds per township per month if some fumigations were not reported. Third, while the various methods used to apply methyl bromide result in significant differences in emission rates over a 24-hour period, it is likely that the application methods have little effect on emission levels over several weeks. The regulatory restrictions already imposed for acute exposures adjust for method differences; these adjustments do not appear to be necessary for subchronic exposure mitigation. However, additional monitoring is needed to verify this assumption.

The effect of time on air concentrations from multiple applications was evaluated by examining the emission rates over time. Several studies have documented methyl bromide emissions over time. These studies indicate that peak emissions occur during and immediately following injection and decrease over time, with a slight increase during tarpaulin removal. Emissions increase slightly during tarpaulin removal, relative to the previous day, but are substantially lower than the day of injection. Emissions are negligible one to two weeks following injection (Majewski, et al., 1995; Rieble, 1994; Williams, et al., 1999; Yates, et al., 1996; Yates, et al., 1997).

Options for Mitigating Subchronic Methyl Bromide Exposure

As DPR evaluates the monitoring results and the risks associated with them, we are considering various risk management options. The options presented reflect factors that would reduce air levels averaged over a season. DPR is not limited to choosing a single option since numerous factors can reduce exposures. A major consideration affecting the analysis is the uncertainty of methyl bromide use in 2001 versus 2000. The implementation of the field fumigation regulations will alter fumigation practices in many ways consistent with the options below. However, it is impossible to quantify these changes in a way that is meaningful to this analysis. In addition, the federally mandated phasedown of methyl bromide production and importation has reduced supplies and made using the chemical increasingly costly. This shrinking availability of methyl bromide poses another unknown variable.

Cap on Amount of Methyl Bromide - Similar to restrictions place on another fumigant, 1,3-dichloropropene (Telone), DPR could limit the amount of methyl bromide in a given area over a given period of time. Using only this approach to achieve eight-week air concentration of 1 ppb would amount to a monthly township cap of 18,000 pounds.

Possible variations: A section cap provides less flexibility for growers and adds minimal additional protection. A county cap provides more flexibility for growers, but subtracts significant protection, because all of a county's allowed use could occur in a relatively small area. Combining allowed use over larger blocks of area or greater time intervals would provide more flexibility, but be more difficult to administer.

Pro: Good technical foundation and easy to explain.
Pro: Most of the regulatory infrastructure and training is already in place.

Con: Does not account for the effect of weather.
Con: Additional county resources required.

Time Windows for Fumigations - Fumigations can be limited to specific time periods to avoid subchronic exposure. The monitoring data shows that the two to five-week reference concentration of 54 ppb was not exceeded even for a single day. This indicates that limiting applications within a time period less than eight weeks and allowing for a break between resumption could provide adequate protection.

Pro: Simple to implement and enforce
Pro: This could allow the current amount of acreage to be treated

Con: Probably cannot change the fumigation window due to weather or other problems

Con: Areas near county borders need to have the same fumigation windows
Con: May have too few fumigation rigs to take full advantage of this option

Increasing Physical or Temporal Separation Between Fumigations - Current requirements require larger buffers for fields separated by less than 1300 feet (1/4 mile) and 36 hours. However, to utilize this option by itself would mean separation of three to four miles and one to two weeks.

Pro: All of the regulatory infrastructure and training is already in place.
Pro: May be easier for counties with few fumigations.

Con: Difficult to administer for counties with many fumigations.

Increase Buffer Zones – Increasing buffer zones will reduce exposure. Buffer zones are one of the cornerstones of the management strategy for acute risks. Although the same approach could be employed for seasonal exposures, the use of buffer zones alone to address seasonal exposures would need to be incredibly large using current assumptions and model to calculate buffers. Alternative methods for calculating buffers using the model will take several months to complete. Using monitoring data, the estimated buffer is three to four miles for 10- to 15-acre fields. The increased buffer zones implemented during the 2001 season may have an effect on reducing seasonal exposures but would be impossible to quantify.

Combinations - It should be possible to combine two or more of the options described above.

Additional Issues and Impacts

Geographic and Seasonal Differences – Because it is possible that there are differences between emissions based on the area of the state, or the season in which the methyl bromide is used, geographic or seasonal adjustments could be made to the mitigation measures, particularly the cap. However, we have insufficient data on how geographic or seasonal factors influence emissions. Additional monitoring would be needed to make these adjustments.

Additional Air Monitoring - DPR has requested ARB monitor for chloropicrin, methyl isothiocyanate (MITC), methyl bromide and 1,3-dichloropropene for 2001. The monitoring is focused on the peak seasons and regions for chloropicrin and metam-sodium applications. These areas coincide with the periods and areas monitored last year. Therefore, this monitoring can also be used to determine the effectiveness of the methyl bromide mitigation measures.

Additional monitoring could determine the effectiveness of the methyl bromide mitigation measures in other high-use areas such as Riverside, Santa Barbara, and Ventura counties. Winter

is the peak season for Riverside. Monitoring in Riverside could determine if there are seasonal or geographic differences.

References

ARB, 2000. Final Report for the 2000 Methyl Bromide and 1,3-Dichloropropene Air Monitoring in Kern County. California Air Resources Board, Sacramento, CA.

ARB, 2001. Final Report for the 2000 Methyl Bromide and 1,3-Dichloropropene Air Monitoring in Monterey and Santa Cruz Counties. California Air Resources Board, Sacramento, CA.

DPR, 1999. Methyl Bromide Risk Characterization Document for Inhalation Exposure (DRAFT RCD 99-02). California Department of Pesticide Regulation, Sacramento, CA.

Majewski, M.S., M.M. McChesney, J.E. Woodrow, J.H. Preuger, and J.N.Seiber. 1995. Aerodynamic Measurements of Methyl Bromide Volatilization from Tarped and Nontarped Fields. J. Environ. Qual., 24: 742-752.

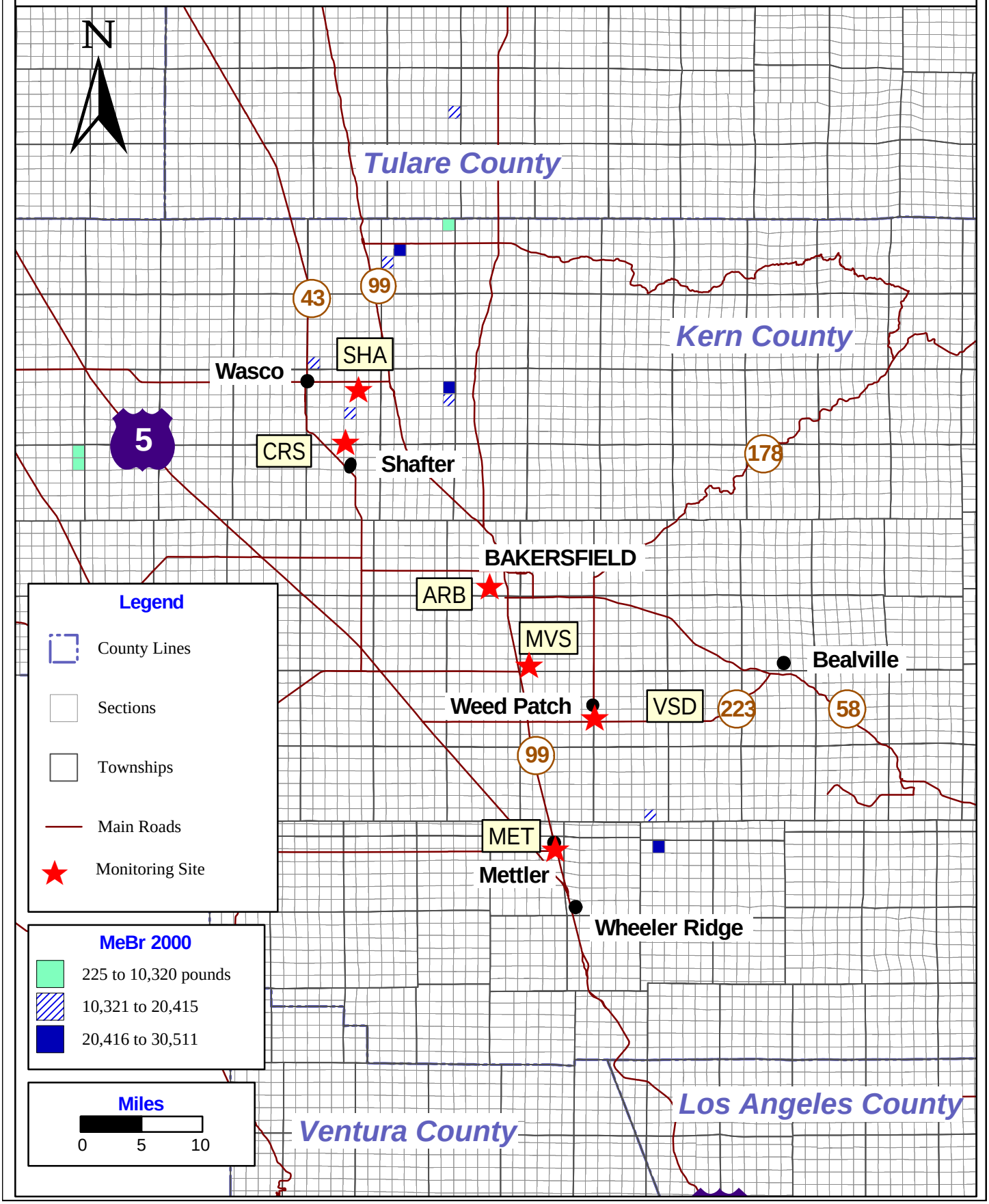
Reible, D.D. 1994. Loss of methyl bromide to the atmosphere during soil fumigation. J. Haz. Mat., 37: 431-444.

Williams, J., N-Y. Wang, and R.J. Cicerone. 1999. Methyl bromide emissions from agricultural field fumigations in California. J. Geophys. Res., 104: 30,087 - 30,096.

Yates, S.R., J. Gan, F.F. Ernst, A. Mutziger, and M.V. Yates. 1996. Methyl Bromide Emissions from a Covered Field: I and II. J. Environ. Qual., 25: 184 - 192.

Yates, S.R., D. Wang, F.F. Ernst, and J. Gan. 1997. Methyl Bromide Emissions from Agricultural Fields: Bare-Soil, Deep Injection. Environ. Sci. Technol., 31: 1136 - 1143.

Location of Monitoring Stations and Methyl Bromide Applications During Ambient Methyl Bromide Monitoring Central Valley - Summer 2000



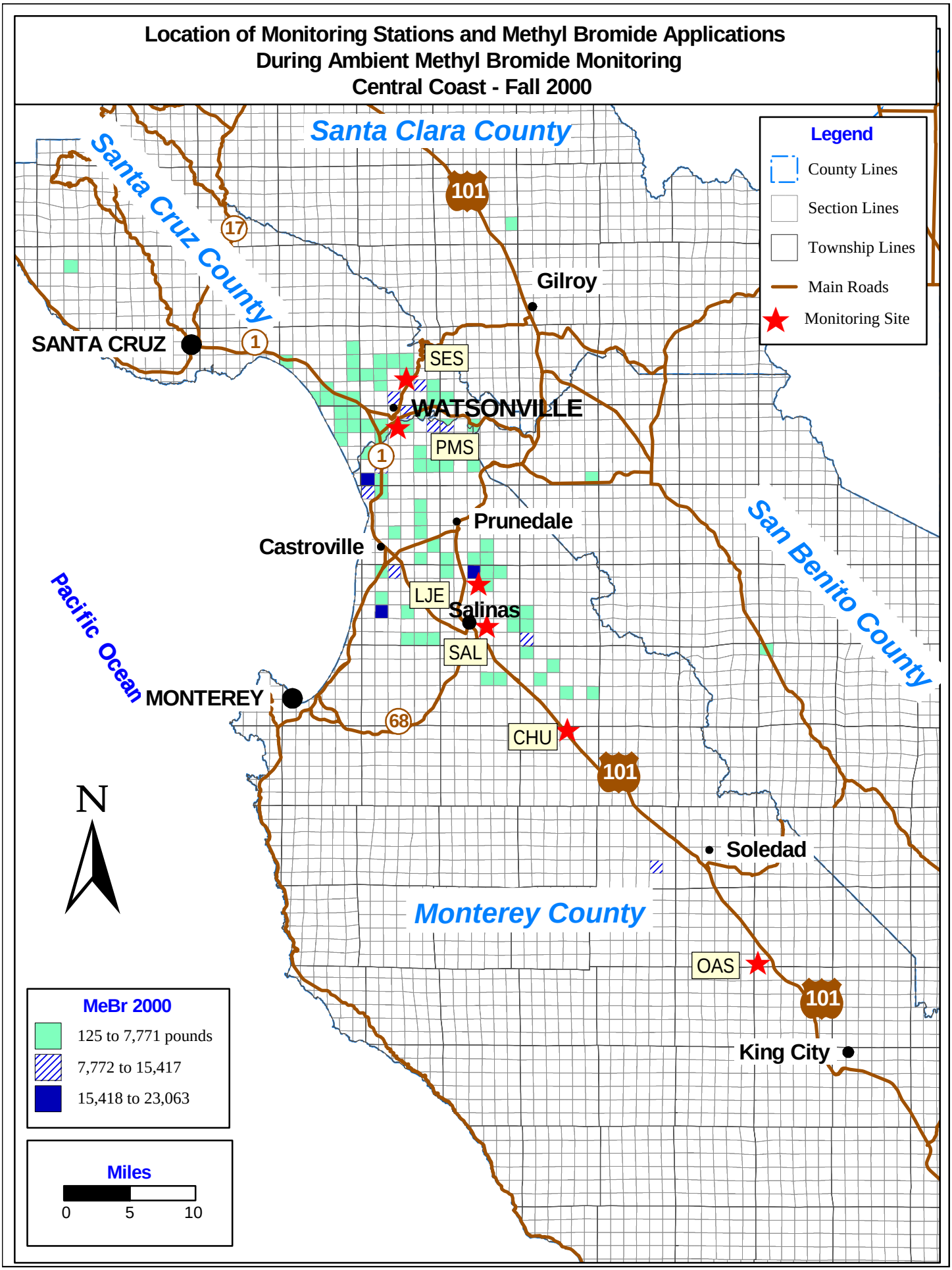

Location of Monitoring Stations and Methyl Bromide Applications
During Ambient Methyl Bromide Monitoring
Central Coast - Fall 2000
Santa Clara County
Santa Cruz County
San Benito County
Pacific Ocean
Monterey County
Legend
County Lines
Section Lines
Township Lines
Main Roads
Monitoring Site
SANTA CRUZ
Gilroy
WATSONVILLE
Prunedale
Castroville
Salinas
MONTEREY
Soledad
King City
SES
PMS
LJE
SAL
CHU
OAS
101
17
1
68
N
MeBr 2000
125 to 7,771 pounds
7,772 to 15,417
15,418 to 23,063
Miles
0
5
10

Figure 3

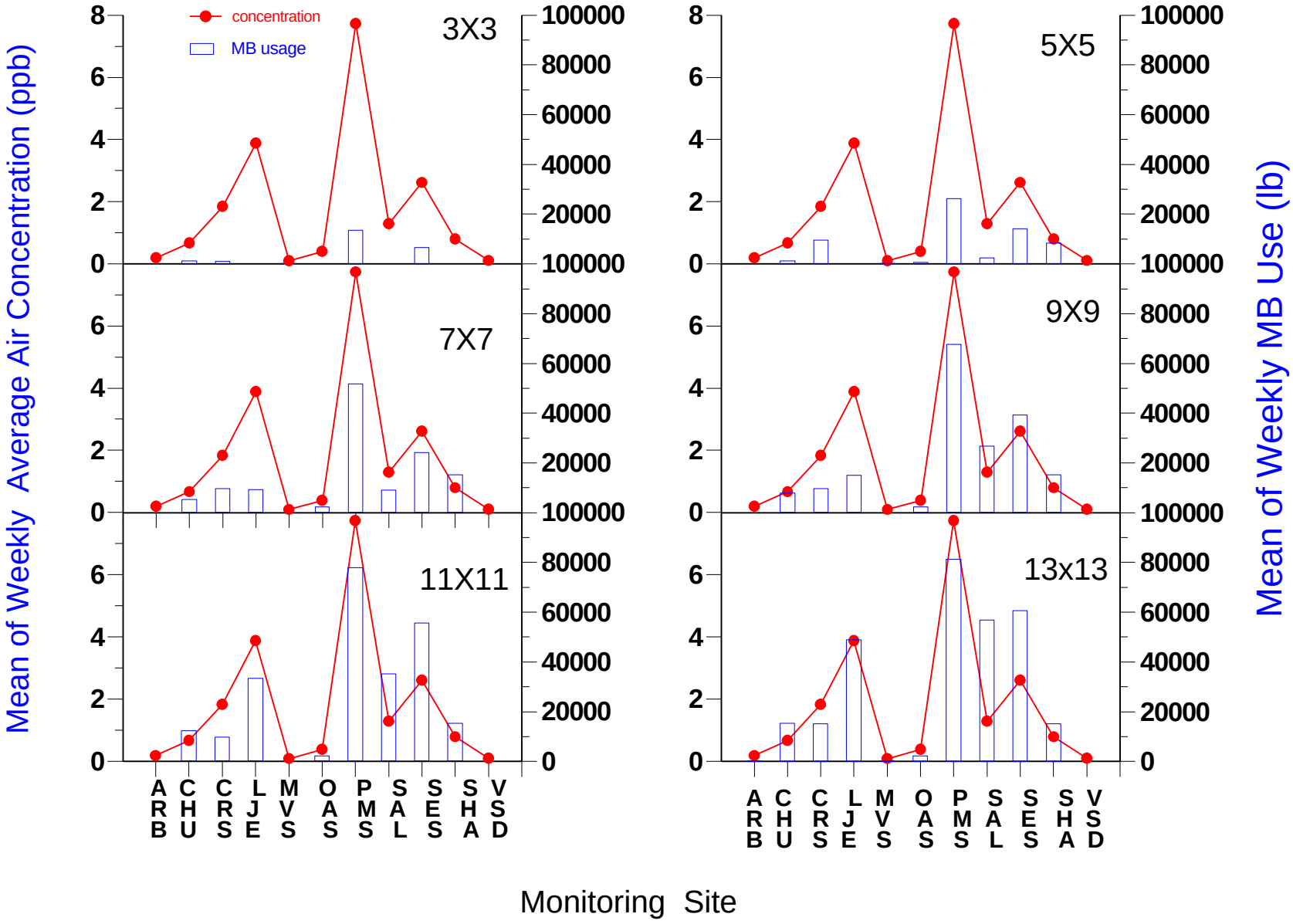

concentration
MB usage
3X3
5X5
7X7
9X9
11X11
13x13
Mean of Weekly Average Air Concentration (ppb)
Mean of Weekly MB Use (lb)
Monitoring Site
ARB
CHU
CRS
LJE
MVS
OAS
PMS
SAL
SES
SHA
VSD

Figure 4

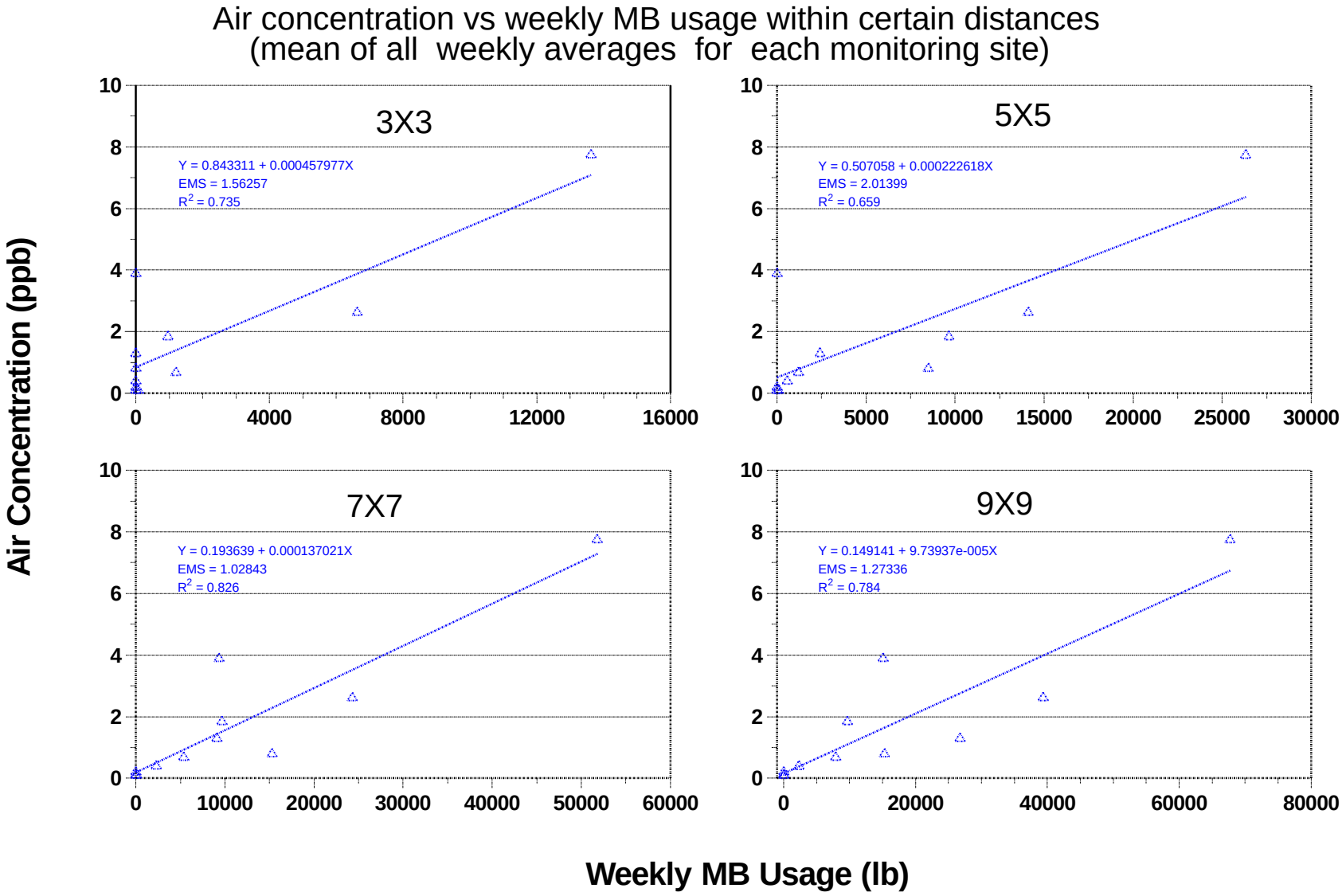

Air concentration vs weekly MB usage within certain distances
(mean of all weekly averages for each monitoring site)
3X3
Y = 0.843311 + 0.000457977X
EMS = 1.56257
R2 = 0.735
5X5
Y = 0.507058 + 0.000222618X
EMS = 2.01399
R2 = 0.659
7X7
Y = 0.193639 + 0.000137021X
EMS = 1.02843
R2 = 0.826
9X9
Y = 0.149141 + 9.73937e-005X
EMS = 1.27336
R2 = 0.784
Air Concentration (ppb)
Weekly MB Usage (lb)

Figure 4, continued

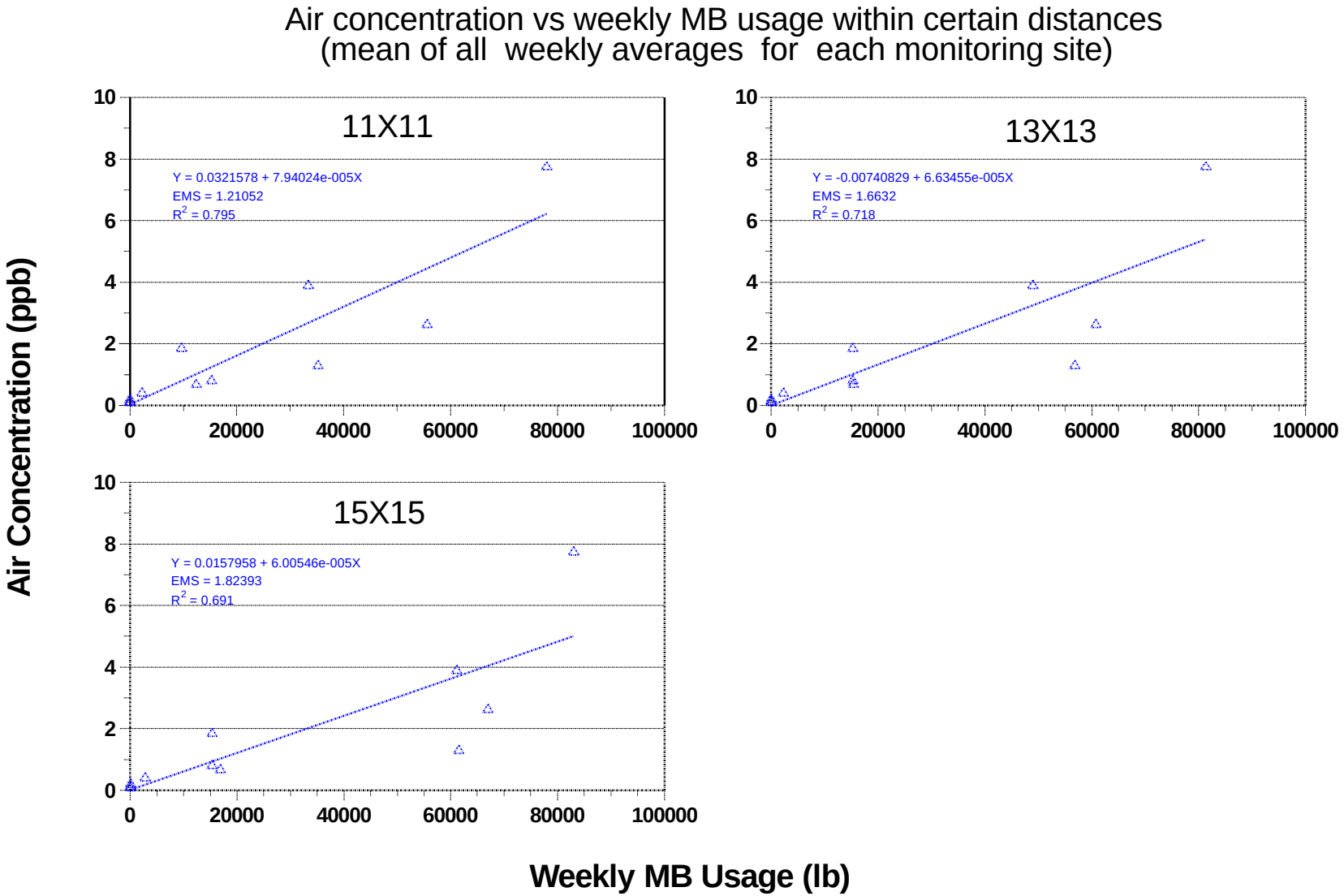


Table 1. Summary of methyl bromide air monitoring results.

Location	Highest 1-Day Concentration (ppb)	Highest 1-Week Concentration (ppb)	Average Concentration for Study Period (ppb)
Monterey and Santa Cruz Counties, Sep 11 - Nov 3, 2000			
CHU Chualar School, Chualar, CA	2.4	1.6	0.6
LJE La Joya Elementary School, Salinas, CA	24.0	11.1	3.8
OAS Oak Avenue School, Greenfield, CA	1.8	1.0	0.4
PMS Pajaro Middle School, Watsonville, CA	30.8	15.5	7.7
SAL Ambient Monitoring Station, Salinas, CA	7.9	3.0	1.3
SES Salsepuedes Elementary School, Watsonville, CA	16.4	8.3	2.6
Kern County, Jul 19 - Sep 1, 2000			
ARB Ambient Monitoring Station, Bakersfield, CA	1.0	0.5	0.2
CRS Cotton Research Station, Shafter, CA	14.2	4.6	2.2
MET Mettler-Fire Station, Mettler, CA	0.2	0.1	0.08
MVS Mountain View School, Lamont, CA	0.5	0.2	0.09
SHA Shafter-Walker Ambient Monitoring Station, Shafter, CA	3.5	1.8	0.8
VSD Vineland School District, Bakersfield, CA	0.3	0.2	0.1
Reference Concentrations			
Child	*250*	*70*	*1*
Adult	*210*	*120*	*2*

Table 2. Monitored average air concentration and reported weekly methyl bromide use in Kern, Monterey and Santa Cruz

County	Site	Concentration (ppb)	Methyl Bromide (lbs)					
			3X3 mi	5X5 mi	7X7 mi	9X9 mi	11X11 mi	13X13 mi
Kern	ARB	0.19	0	0	0	45	45	45
Kern	MVS	0.09	77	77	77	77	77	77
Kern	CRS	1.84	955	9671	9671	9671	15308	15308
Kern	SHA	0.79	0	8492	15308	15308	15308	15308
Kern	VSD	0.10	0	0	0	0	0	32
Monterey	PMS	7.73	13633	26326	51829	78006	81350	83067
Monterey	SAL	1.29	0	2425	9125	35215	56830	61532
Monterey	CHU	0.67	1202	1202	5360	12444	15384	16886
Monterey	LJE	3.88	0	0	9360	33419	48966	61120
Monterey	OAS	0.39	0	591	2306	2306	2306	2803
Santa Cruz	SES	2.61	6629	14111	24311	55635	60765	66952

Table 3. R^2 between weekly average air concentration and the weekly methyl bromide usage

Area (mi)	Time frame on average values		
	1 week (n = 83)	4 week (n = 22)	8 week (n = 11)
3x3	0.484	0.615	0.735
x5	0.348	0.462	0.659
7x7	0.458	0.591	0.826
9x9	0.455	0.573	0.784
11x11	0.463	0.628	0.795
13x13	0.427	0.588	0.718
15x15	0.419	0.577	0.691

Table 4. Weekly methyl bromide use limit in order to meet 1 ppb target level

Distance (mi)	Area (mi)	a	b	R^2	X|y = 1 ppb	Section (lb)	Township (lb)
1	3X3	0.8433	0.000458	0.735	342	38	1369
2	5X5	0.5070	0.000223	0.659	2214	89	3189
3	7X7	0.1936	0.000137	0.826	5885	120	4324
4	9X9	0.1582	9.72E-05	0.771	8663	107	3850
5	11X11	0.0321	7.94E-05	0.795	12189	101	3627
6	13X13	-0.0074	6.63E-05	0.718	15184	90	3235
7	15X15	0.0158	6.01E-05	0.691	16388	73	2622